

## STATUS OF SOME HISTORICALLY UNFAMILIAR AMERICAN MAYFLIES (EPHEMEROPTERA)

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*Abstract.*—The status of each of 10 American species of Ephemeroptera that have not been reported for at least the past half century is evaluated. *Isonychia diversa* Traver and *Siphonurus luridipennis* (Burmeister) are declared recently extinct, and *Ephemera compar* Hagen and *Pentagenia robusta* McDunnough are confirmed as such. The documented extirpation of the closely related European *Palingenia longicauda* (Olivier) may be indicative of the disappearance of *P. robusta* in North America. *Ephemera triplex* Traver, *Ephemerella ora* Burks, *Isonychia notata* Traver, *Leptophlebia grandis* (Traver), *Nixe otiosa* (McDunnough), and *N. rodocki* (Traver) are shown to be new junior synonyms of certain other, better known congeneric American species.

*Key Words.*—Insecta, Ephemeroptera, North American species, extinctions, new synonyms.

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The recent turn of the century has marked the passing of approximately 200 years of describing the North American mayfly fauna (McCafferty 2001). Of the nearly 700 species presently known in North America, however, there are certain species known only from old historical records and usually based only on the original material from which they were described. Considering the ever increasing need to document biodiversity accurately and to gauge the possible vulnerability of species and their habitats, it has become important to re-examine the status of those historically unfamiliar species. If possible, it should be determined whether these unfamiliar species are valid, and if they are not valid, establish a concomitant synonymy. If they are valid, it should be further determined if they are truly restricted and rare, poorly sampled, or extinct. Otherwise, such historically unfamiliar species will continue to be presumed extant but rare and perhaps endangered species. This research is adjunct to the nationally sponsored North American Ephemeroptera database project at Purdue University.

The purpose of the study was to evaluate the status of 10 of the American species of mayflies described prior to 1950 that have never been reported since. Other species remain that currently fall into this category, but they are not treated here for various reasons, often because they are being treated elsewhere as part of continuing generic revisions.

The following narrative analyses are given in alphabetical order. Depositions of studied material, when applicable, are indicated within the text.

### *EPHEMERA COMPAR* HAGEN

This species was based on a single male adult specimen from Foothills, Colorado (Hagen 1875), a locality that has remained dubious (see Edmunds & McCafferty 1984). George Edmunds studied the type of this species while visiting the Museum of Comparative Zoology at Harvard University in the 1950s. Edmunds (personal communication) came to the conclusion that this species was distinct from all other known species of *Ephemera*. Based on drawings of the type specimen rendered by Edmunds and recent comparisons with other North American species (including types), *E. compar* must be considered a valid species. Hagen (1875) was correct that *E. compar* was reminiscent of the European species

*E. lineata* Eaton (e.g., see Elliott & Humpesch 1983), although Traver (1935) intimated that it was near the widespread American species *E. simulans* Walker. Despite the call to search for this species in the appropriate areas of Colorado by Edmunds & McCafferty (1984) and extensive field work and ecological studies carried out on Colorado waters that have involved mayflies [see reports reviewed by McCafferty et al. (1993)], the species has not been found and should continue to be considered extinct, as first indicated by McCafferty (1996).

*EPHEMERA TRIPLEX* TRAVER

This species was described from adults taken from four localities in West Virginia in 1930 and 1931 (Traver 1935). It has not been reported subsequently, although considerable collections have been made in the area (e.g., Faulkner & Tarter 1977, Berner 1977, Kondratieff & Voshell 1983). Examination of types held at Cornell University and the study of additional material of *E. blanda* Traver from various states and localities (McCafferty 1975, 1994) revealed no substantial morphological or color difference between *E. triplex* and *E. blanda* (Traver 1932). In type material of both, background body coloration is light, markings are identical and often not very dark, and wings are essentially without pattern, although one or two very small light clouds are present in the forewings of some paratypes of *E. triplex*. Size and male genitalia of both are similar and also similar to that of *E. varia* Eaton. Given variation in wing staining in *E. varia* and *E. simulans* Walker, slight staining associated with *E. triplex* cannot be used in exclusion of other characteristics to uphold the name, and it is therefore placed as a subjective junior synonym of *E. blanda*, NEW SYNONYM.

*EPHEMERELLA ORA* BURKS

This species was described from a single male and a single female adult taken at Mt. Carmel, Illinois in 1946 (Burks 1947). The date attributed to the species description was incorrectly given as 1949 by Allen & Edmunds (1965) and has been inaccurately repeated as such in subsequent listings. The species has not been reported subsequently (e.g., Randolph & McCafferty 1998).

Burks (1947) stated that if it had not been for the pinkish tan eyes of the his live male specimen assigned to *E. ora*, he would have identified his specimens as *E. excrucians* Walsh. This was because Walsh (1862) had indicated that the eyes of his *E. excrucians* were egg-yellow. Subsequent to Burks' description, Leonard & Leonard (1962) had indicated the eyes of *E. excrucians* were orange-yellow, and Allen & Edmunds (1965) described them as pale orange. The male genitalia and the essential color pattern of the adults are the same in *E. ora* and examined materials of *E. excrucians*. [Allen & Edmunds (1965) designated a lectotype for *E. excrucians* and provided a figure of its genitalia.] Eye color may vary intraspecifically—it can vary depending on how long the adults have lived, and even appear different depending on the angle of light on the eye. This has been witnessed routinely in adults of the common species *Stenacron interpunctatum* (Say). George Edmunds (personal communication) has witnessed eye color change in live adults with the time of day, for example, in the genus *Ameletus* Eaton. In the absence of structural and color pattern differences, eye color alone cannot be safely used as a species-defining characteristic, and *E. ora* is here placed as a subjective junior synonym of *E. excrucians*, NEW SYNONYM.

*ISONYCHIA DIVERSA* TRAVER

This species was described by Traver (1934) from a single male adult taken in 1916 at Knoxville, Tennessee. A male subimago was also taken from the site three weeks later in 1916 (Kondratieff & Voshell 1984). As part of their revision of the *Isonychia* Eaton species in North America, Kondratieff & Voshell (1984) examined the type of the species held at Cornell University, redescribed the species, and having determined that it was highly distinctive within the genus, considered it as the exclusive member of a unique species grouping they referred to as the "*diversa* group". On the basis of a cladistic analysis, the *diversa* group was recognized as the subgenus *Borisonychia* McCafferty (McCafferty 1989). The subgenus and species are remarkable because of unique mushroom shaped penes.

Mayflies of East Tennessee are relatively well known (e.g., Long & Kondratieff 1996), as are nearby regions of North Carolina (see discussion of *Siphonurus luridipennis*, below), but *I. diversa* has not been reported. Also, *Isonychia* spp. are well known to be attracted to lights. Considering that the extraordinary species is clearly valid, and given that considerable collecting efforts have not produced the species in nearly 85 years, *I. diversa* is here considered a recently extinct American species.

*ISONYCHIA NOTATA* TRAVER

This species has been known only from the holotype female adult reared from a larva and one other, immature larva indirectly associated with the female. The specimens were collected in 1930 from Bald Creek, North Carolina (Traver 1932). Subsequent collecting at the type locality by B. C. Kondratieff did not produce females that exactly matched Traver's description (Kondratieff & Voshell 1984), nor males that could possibly represent *I. notata*. Other sampling in the vicinity over the past 70 years has also not produced adults that might be identified as such, and the report of *I. notata* from North Carolina by Berner (1977) was shown by Kondratieff & Voshell (1984) to be a misidentification of *I. georgiae* McDunnough.

The only possibly distinguishing characteristic assigned specifically to *I. notata* is some distal coloration of the midtibiae in the female adult; the associated larvae are not distinguishable specifically from other larvae of the subgenus *Prionoides* Kondratieff & Voshell (Kondratieff & Voshell 1984). Overall, *I. notata* is similar to *I. georgiae*. The slight color variation in the tibiae of the female adult, at the exclusion of other distinguishing characteristics, however, is not reliable, and *I. notata* is here placed as a subjective junior synonym of *I. georgiae*, NEW SYNONYM.

*LEPTOPHLEBIA GRANDIS* (TRAVER)

This species (as *Blasturus* Eaton) was described from reared male and female adults and associated larvae taken from two lakes and a stream in the vicinity of Greensboro, North Carolina (Traver 1932). Traver (1932) described another species, *L. intermedia* (Traver), from a tributary of Cape Fear River near Buies Creek, North Carolina. Unlike *L. grandis*, *L. intermedia* has subsequently been collected throughout the Southeast (see Berner 1950, 1958, 1977).

Berner & Pescador (1988) discussed similarities of *L. intermedia* and *L. grandis*. Minor body size and slight difference in the length of the median caudal

filament relative to the cerci remain the only traits that might possibly differentiate the two. Male genitalia, wing staining, and larval morphology reportedly will not differentiate them. Berner & Pescador (1988) stated "Circumstantial evidence points to synonymy of the two species; however, we are not yet taking the action of equating them." Size (little more than 10% difference) cannot be used to uphold *L. grandis*, particularly in light of findings of the effect of local developmental temperature regime on body size, etc. within the same species (e.g., McCafferty & Pereira 1984). *L. grandis* is therefore placed as a subjective junior synonym of *L. intermedius*, NEW SYNONYM. Because there is no chronological priority of either name over the other, prerogative of the first reviser is invoked in considering *L. intermedius* the senior name, even though *L. grandis* has page priority.

*NIXE OTIOSA* (MCDUNNOUGH)

This species (as *Heptagenia* Walsh) was based on a single male adult taken at Maupin, Oregon in 1934 (McDunnough 1935). Traver (1935) realized that it was very similar to the relatively common western species *Nixe criddlei* (McDunnough), for example, with respect to the presence of short foretarsi associated with males. The genitalia are fundamentally similar, and the supposed differences in tint or degree of brown coloration in the two is of little consequence because of variability witnessed in populations of *N. criddlei* from throughout the West held in the Purdue Entomological Research Collection (PERC hereafter). The only possible differences that might support the validity of *N. otiosa* are differences that may seem to be present in genitalia based on figures assigned to each. However, if one compares the figures of the ventral genitalia labeled as "*n. sp. McD.*" (= McDunnough's single specimen of *N. otiosa*) and "*criddlei*" in Traver's (1935) figure 98, it is apparent that the genitalia of *N. otiosa* are simply a distortion of those drawn for *N. criddlei*. This was likely due in part to the genitalia of *N. otiosa* being drawn from a dry specimen rather than from fluid preserved genitalia that were then slide mounted, as was probably the case in all of the other species represented in figure 98 and elsewhere in Traver (1935). Medial spines appear high on the penes in *N. otiosa* (compared with all other drawings of related species, where the medial spines are shown in their natural basomedial position); and the spine that appears mediodistally on the ventral face of the penes in *N. criddlei* was incorrectly interpreted by Traver to be an additional and unique apical spine, as seen on the distorted penes drawn for *N. otiosa*. Another classic case of penes distortion in North American heptageniid mayflies was discussed and illustrated in detail with respect to *Anepeorus* McDunnough species by McCafferty & Provonsha (1985).

Although Traver (1935) indicated that there was some genitalic difference between *N. otiosa* and *N. criddlei*, Edmunds (in Bednarik and Edmunds 1980) stated that Traver had told him on several occasions that she believed *N. otiosa* was a synonym of *N. criddlei*. *Nixe otiosa* is here placed as a subjective junior synonym of *N. criddlei*, NEW SYNONYM.

*NIXE RODOCKI* (TRAVER)

This species was described (as *Heptagenia*) from four male adults and one female adult taken at Lewiston, Idaho in 1931 (Traver 1935). It was not found

by Jensen (1966) in his survey of Idaho mayflies, and it has not been found by more recent workers in Idaho (G. Lester, personal communication). As pointed out by Bednarik & Edmunds (1980), it could possibly represent a variant of *Nixe simplicioides* (McDunnough), which is a widespread western species common in the Lewiston area. Traver's slide mounts of male genitalia associated with her species were obviously distorted to various degrees [see the two drawings of "rodocki" given in figure 98 in Traver (1935)]; also note that Traver's comment, that the species was unique because of "the peculiar long and twisted median spines on the penes," is curiously based on the obviously squashed and distorted genitalia drawn rather than the better mounted genitalia that was also drawn. Bednarik & Edmunds (1980) concluded that the only possible difference between *N. rodocki* and *N. simplicioides* was the presence of markings on the male abdomen of the former. Close reading of Traver's (1935) comments about *N. rodocki*, however, indicates that she did not find the dark patches on all five of her specimens and that such patches were difficult to see even when present.

A large series of *N. simplicioides* in PERC from the Payette River, 10 miles east of Payette, Idaho, demonstrated no abdominal maculation in adults. McDunnough (1926) indicated that adult specimens of Heptageniidae left too long in killing jars or subjected to moisture after death tend to darken. Edmunds (personal communication) surmised that this phenomenon might explain why Traver had specimens with darker abdomens. It was normal in 1931, when R. E. Rodock collected the original material of *N. rodocki*, for entomologists to use killing jars for fixing adult mayflies, rather than today's more common method of fluid fixation and preservation. Edmunds (personal communication) and his colleagues regularly collected *N. simplicioides* from the type locality of *N. rodocki*, but never saw darkened specimens as described for *N. rodocki* by Traver (1935). *Nixe rodocki* is here formally placed as a subjective junior synonym of *N. simplicioides*,  
NEW SYNONYM.

#### *PENTAGENIA ROBUSTA* MCDUNNOUGH

This species was described from Ohio by McDunnough (1926), based on a single male adult taken at Cincinnati. Examination of the specimen in the Canadian National Collection in the 1970s confirmed that the characteristics assigned to it by McDunnough were accurately represented. The well-known North American species *P. vittigera* (Walsh) is the only other recognized species of *Pentagenia*. Based on ample material of *P. vittigera* adults from a number of localities throughout its range (e.g., Lugo-Ortiz & McCafferty 1995, Randolph & McCafferty 1998), there is no variability that suggests that *P. robusta* is a variant of *P. vittigera*. McCafferty (1996) first regarded the species as being recently extinct.

A close relative of the Nearctic genus *Pentagenia* Walsh is the Palearctic genus *Palingenia* Burmeister (McCafferty & Edmunds 1976, McCafferty 1991). *Palingenia longicauda* (Olivier) was once very common throughout much of Europe. The longer recorded history of the insect fauna in Europe clearly indicates a relatively recent extirpation of *P. longicauda* that apparently may be associated with human population growth, industrialization, and the increases in river usage. This documentation not only demonstrates the vulnerability of some of the large clay-burrowing mayflies such as *Pentagenia* and *Palingenia*, but certainly may be instructive in terms of similar situations in North America related to the dis-

appearance of *P. robusta* from the Ohio River, or the potential for the extinction of other large-river mayflies. Russev (1987) showed that between the years 1634 and 1900, *P. longicauda* occurred widely throughout Europe (from the Netherlands, Belgium and France to the Ukraine, Romania and Bulgaria) in the lower and middle courses of large and medium sized rivers. Between 1901 and 1927, the species became extirpated in western Europe and had become rare in central Europe. Between 1928 and 1978, *P. longicauda* populations existed only in far southeastern Europe in the lower Danube River and certain tributaries of the Tissa River, itself a tributary of the Danube.

*SIPHONURUS LURIDIPENNIS* (BURMEISTER)

This species was based on a single female adult taken in North Carolina and originally considered in *Baetis* Leach by Burmeister (1839). Beginning with Hagen (1861), however, there was considerable confusion about this species, and the name was misapplied to the somewhat common eastern North American heptageniid species *Stenonema pulchellum* (Walsh). This incorrect concept was continued by Eaton (1871) and led to further misuse of the name and misidentifications of *S. pulchellum* in Canada, for example, by Clemens (1913) and Walley (1927) (see Traver 1935, McCafferty & Randolph 1998). Although not collected, the species has remained on recent national and local faunal lists (e.g., McCafferty 1997, Pescador et al. 1999).

Ulmer (1926) studied the type specimen of *S. luridipennis*, located in the Zoological Institute of the University of Halle, gave a detailed accounting of the species, and placed it in the genus *Siphonurus* Eaton. Traver (1935) provided an English translation of Ulmer's German account. The species is highly distinctive among the 20 species of North American *Siphonurus*. The most diagnostic feature is the size of the wings of the species. The body length is 16 mm, which is only slightly longer than most other species in the genus (although there may have been some shrinkage of the pinned specimen); however, the wings are much longer than those found in other North American species (20 mm in length vs. 9–14 mm in other species). Although there are Chinese species this large, North American workers might wonder if the female actually belongs to some other genus with such body and wing size but also with wing venation similar to that of *Siphonurus*, such as *Siphonisca* Needham (known only from the Northeast), *Isonychia*, perhaps the little known genus *Acanthametropus* Tshernova (the latter two known from the Southeast, and the lattermost rare), or even the genus *Siphuriscus* Ulmer. However, absolute forewing length and relative forewing length associated with the various species in these other genera do not correspond with that of *S. luridipennis*. Also, *Acanthametropus* is three tailed as an adult [Bajkova (1970) as *Isonychia polita* Bajkova]; *Siphonisca* has some highly distinguishing characteristics associated with it such as lateral abdominal flanges (e.g., McCafferty & Edmunds 1997); Ulmer would have been familiar with *Isonychia*; and Ulmer would also certainly have been familiar with *Siphuriscus* because he had described that genus earlier from China (Ulmer 1920).

Despite the species' distinctiveness and the fact that North Carolina is perhaps one of the most collected areas in the world as far as mayflies are concerned (e.g., Traver 1932, 1933; Lenat & Penrose 1987), *S. luridipennis* has not been found

in some 160 years and should now be considered a recently extinct American species.

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